TRIAL TEST 6 – ACIDS AND BASES

- Time allowed: 45 minutes
- Total marks: 35

Part 1 – Multiple Choice	– 10 marks
Part 2 – Short Answer	– 15 marks
Part 3 – Calculation	– 5 marks
Part 4 – Extended Answer	– 5 marks

Part 1 – Multiple Choice (1 mark per question)

1. A solution made by dissolving ammonium chloride in water would

   (a) be a weak conductor of electricity because ammonium is a weak base.
   (b) not affect blue litmus paper because the solution would not contain any H^+ ions.
   (c) be acidic because the chloride ions react with water to form HCl molecules.
   (d) be basic because the solution would have a hydroxide ion concentration of less than 1.00×10^{-7} mol L^{-1}.
   (e) turn blue litmus red because the hydrogen ion concentration is greater than 1.00×10^{-7} mol L^{-1}.

2. Which of the following equations shows the first reactant listed acting as a Brønsted-Lowry base?

   (a) $2H_2O(l) + 2Na(s) \longrightarrow 2NaOH(aq) + H_2(g)$
   (b) $H_2PO_4^-(aq) + H_2O(l) \rightleftharpoons HPO_4^{2-}(aq) + H_3O^+(aq)$
   (c) $CH_3COO^-(aq) + H_2O(l) \rightleftharpoons CH_3COOH(aq) + OH^-(aq)$
   (d) $HS^-(aq) + CO_3^{2-}(aq) \rightleftharpoons S^{2-}(aq) + HCO_3^-(aq)$
   (e) $H_2O(l) \rightleftharpoons OH^-(aq) + H^+(aq)$

3. Which of the following represents a dilute solution of a weak base?

   (a) 0.20 mol L^{-1} H_2SO_4
   (b) 0.20 mol L^{-1} NaOH
   (c) 0.20 mol L^{-1} Na_2CO_3
   (d) 0.20 mol L^{-1} NaCl
   (e) 0.20 mol L^{-1} $Ca(OH)_2$

4. The pH of a 0.001 mol L^{-1} HCl solution is

   (a) 1.0×10^{-3}
   (b) 3
   (c) 11
   (d) –3
   (e) 4

5. Which of the following lists contains an acidic, a basic and a neutral substance?

(a)	$LiOH$	,	H_2O	,	$CaCO_3$
(b)	$Ca(OH)_2$	,	$NaCl$	,	KNO_3
(c)	CO_2	,	NH_3	,	Na_2CO_3
(d)	$MgCl_2$	,	MgO	,	NO_2
(e)	H_2S	,	H_2O	,	SO_3

6. Which of the following statements is correct?

(a) Sea water is slightly basic as it has a pH slightly less than 7.
(b) Sodium carbonate is a weak base because it is only slightly soluble in water.
(c) Barium oxide can react with acids and bases and so is called an amphoteric oxide.
(d) Ammonia is more soluble in water than $Mg(OH)_2$ and so is a stronger base.
(e) Rain water that turns blue litmus red has a $[H^+] > [OH^-]$.

7. When a solution is formed by dissolving 1 mole of phosphoric acid in 1 litre of water, which of the following would be present in the greatest concentration?

(a) H_3PO_4 molecules
(b) H^+ ions
(c) $H_2PO_4^-$ ions
(d) HPO_4^{2-} ions
(e) PO_4^{3-} ions

8. A detergent has a pH of 8.00. The hydroxide ion concentration of the detergent is

(a) impossible to determine unless the volume of detergent is known.
(b) greater than the hydrogen ion concentration.
(c) equal to 1.00×10^{-8} mol L^{-1}.
(d) 8.00×10^{-6} mol L^{-1}.
(e) increased when added to washing up water with a pH of 7.

9. Which of the following is NOT correct?

(a) A solution of SO_2 would have a pH < 7.
(b) Red litmus paper would turn blue when placed in a solution of sodium carbonate.
(c) Zinc oxide does not dissolve in caustic soda solutions.
(d) Calcium carbonate can be dissolved by water containing carbon dioxide.
(e) It is not possible to produce a hydrochloric acid solution with a hydrogen ion concentration of 1.00×10^{-8} mol L^{-1}.

10. A product of the reaction between sodium sulfite and hydrochloric acid would be

(a) hydrogen sulfide.
(b) sodium sulfate.
(c) sulfuric acid.
(d) sulfur dioxide.
(e) sodium thiosulfate.

END OF PART 1

Part 2 - Short Answer **Answer each question in the space provided beneath the question.**

11. Explain why a strip of magnesium ribbon would be dissolved more rapidly by a 1.00 mol L^{-1} HNO_3 solution than by a 1.00 mol L^{-1} H_2CO_3 solution.

[2 marks]

12. Rank the following solutions in order of increasing pH.

1 mol L^{-1} Na_2CO_3 , 1 mol L^{-1} HNO_3 , 1 mol L^{-1} NaCl ,
1 mol L^{-1} KOH , 1 mol L^{-1} CH_3COOH

[2 marks]

13. Briefly describe an experiment that could be used to determine the strength of a collection of acids.

[2 marks]

14. Calculate the $[H^+]$ and $[OH^-]$ for a sodium hydroxide solution that has a pH of 12.0.

[2 marks]

15. With the aid of an equation, explain why water is considered to be a weak electrolyte.

[2 marks]

16. Aluminium hydroxide is classified as an amphoteric hydroxide. Use equations to explain why.

[2 marks]

17. Write balanced equations (ionic where appropriate) for the following reactions.

(i) barium hydroxide solution + sulfuric acid

(ii) hydrochloric acid + solid calcium oxide

(iii) ammonium nitrate solution + potassium hydroxide solution

[3 marks]

END OF PART 2

Part 3 - Calculation **Show all relevant working in the space provided beneath the question.**

18. Calculate the volume of carbon dioxide produced at 105 kPa pressure and 27.0°C when 2.50 L of 0.500 mol L^{-1} HCl reacts with excess calcium carbonate.

[5 marks]

END OF PART 3

Part 4 - Extended Answer

19. Use their properties and appropriate theories to explain the differences between acidic and basic solutions.

[5 marks]

END OF TEST **TOTAL 35 MARKS**

TRIAL TEST 6 SOLUTIONS – Acids and Bases

Part 1

1. *e*
2. *c*
3. *c*
4. *b*
5. *d*
6. *e*
7. *a*
8. *b*
9. *c*
10. *d* [10]

Part 2

11. *The reaction occurs between H^+ ions and the Mg ribbon. HCl is a strong acid and so will have a greater concentration of H^+ ions than H_2CO_3 which is a weak acid. The greater the $[H^+]$, the greater the reaction rate.* [2]

12. HNO_3 , CH_3COOH , $NaCl$, Na_2CO_3 , KOH [2]

13. *Produce solutions of equal concentrations and test the conductivity of the acids. The greater the conductivity the more the acid has broken up into it constituent ions (e.g. $HCl_{(aq)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$) and the greater its strength.* [2]

14. $pH = -\log [H^+]$
$[H^+] = inv\ log\ (pH)$
$[H^+] = 1.00 \times 10^{-12}\ mol\ L^{-1}$

$$[OH^-] = \frac{1.00 \times 10^{-4}}{1.00 \times 10^{-12}}$$

$[OH^-] = 1.00 \times 10^{-2}\ mol\ L^{-1}$ [2]

15. *Water is a weak electrolyte because it ionises to a very small extent.*
ie. $H_2O_{(l)} \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)}$
where $[H^+] = [OH^-] = 1.00 \times 10^{-7}\ mol\ L^{-1}$ [2]

16. *Amphoteric substances are capable of reacting with acids and bases.*
eg. Reaction with acid:
$Al(OH)_{3(s)} + 3H^+_{(aq)} \longrightarrow Al^{3+}_{(aq)} + 3H_2O_{(l)}$
Reaction with base:
$Al(OH)_{3(s)} + OH^-_{(aq)} \longrightarrow Al(OH)_4^-{}_{(aq)}$ [2]

17. *(i)* $Ba^{2+}_{(aq)} + 2OH^-_{(aq)} + 2H^+_{(aq)} + SO_4^{2-}{}_{(aq)} \longrightarrow BaSO_{4(s)} + 2H_2O_{(l)}$
(ii) $2H^+_{(aq)} + CaO_{(s)} \longrightarrow Ca^{2+}_{(aq)} + H_2O_{(l)}$
(iii) $NH_4^+{}_{(aq)} + OH^-_{(aq)} \longrightarrow NH_{3(aq)} + H_2O_{(l)}$ [3]

Part 3

18. $\overset{known}{2HCl} + CaCO_3 \longrightarrow \overset{unknown}{CaCl_2} + CO_2 + H_2O$
$n(HCl) = c\,V = 0.500 \times 2.50 = 1.25$
$n(CO_2) = \frac{1}{2}\,n\,(HCl) = 0.625$

$$V(CO_2) = \frac{n\,R\,T}{P}$$

$$= \frac{0.625 \times 8.315 \times (27.0 + 273.1)}{105}$$

$V(CO_2) = 14.9\ L$ [5]

Part 4

19. *Differences in properties:*
i) acids taste sour, bases taste bitter
ii) bases feel slippery or soapy
iii) acids react with some metals to form hydrogen gas, bases only react with amphoteric metals to produce hydrogen gas
iv) acids turn blue litmus red, bases turn red litmus blue.
Theories:
Arrhenius: *acids produce H^+ ions in solution while bases produce OH^- ions.*
Brønsted-Lowry: *acids act as proton donors, bases as proton acceptors.*

eg. $\overset{acid}{HCl} + \overset{base}{NaOH} \longrightarrow NaCl + H_2O$
donates a H^+ — *to form*

[5]

MARKS **Total = 35**